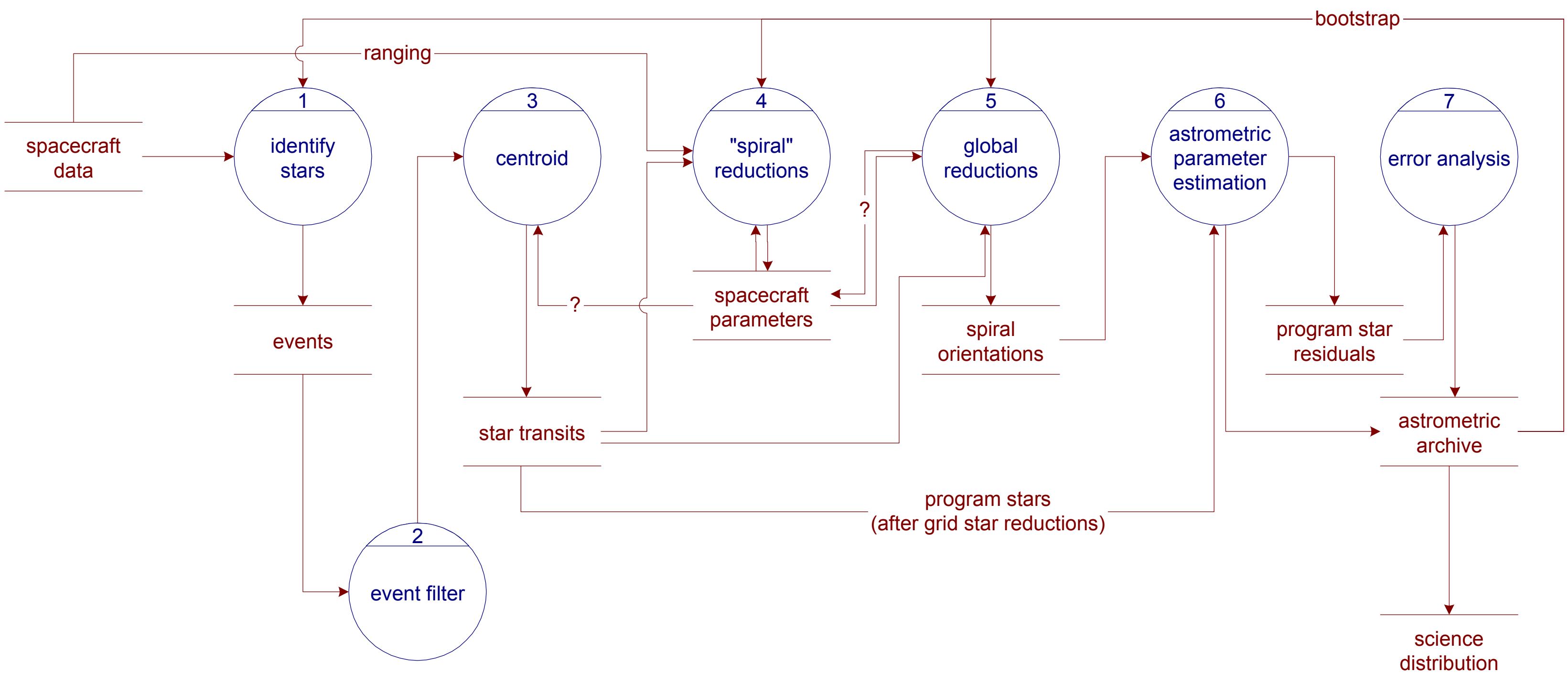
Data Analysis Pipeline
Spiral Reduction Prototype Pipe

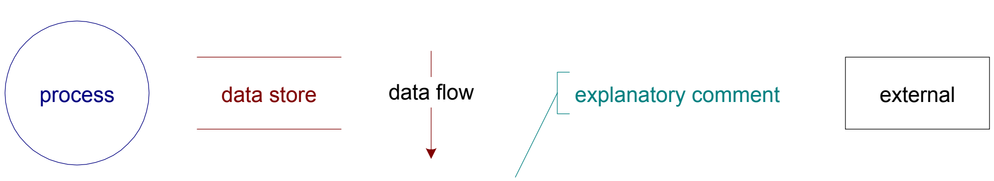
- Where it fits into the pipeline (as now conceived)
- Basis
- Flow chart and organization
- A few details
  - Time variables
  - Changes to NOVAS
- Status
- Next steps

FAME Data Reduction Overview DFD: Astrometric Pipeline

19 March, 2001

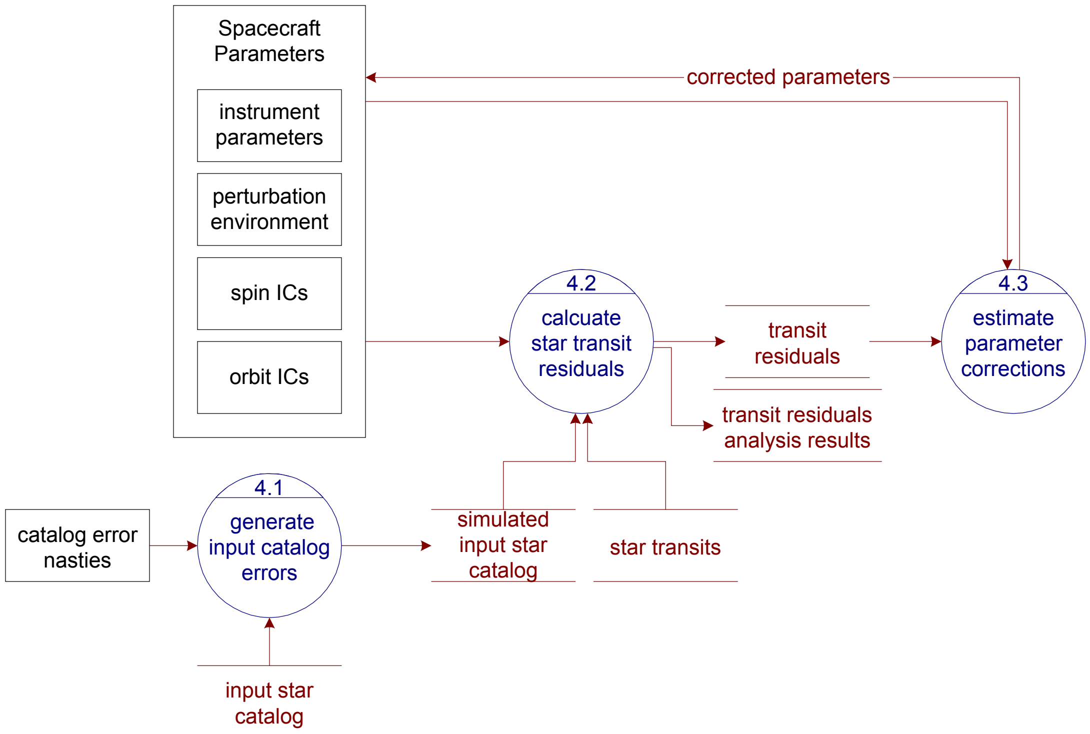


Symbol Key:



FAME Spiral Segment Reduction DFD: Overview

19 March, 2001



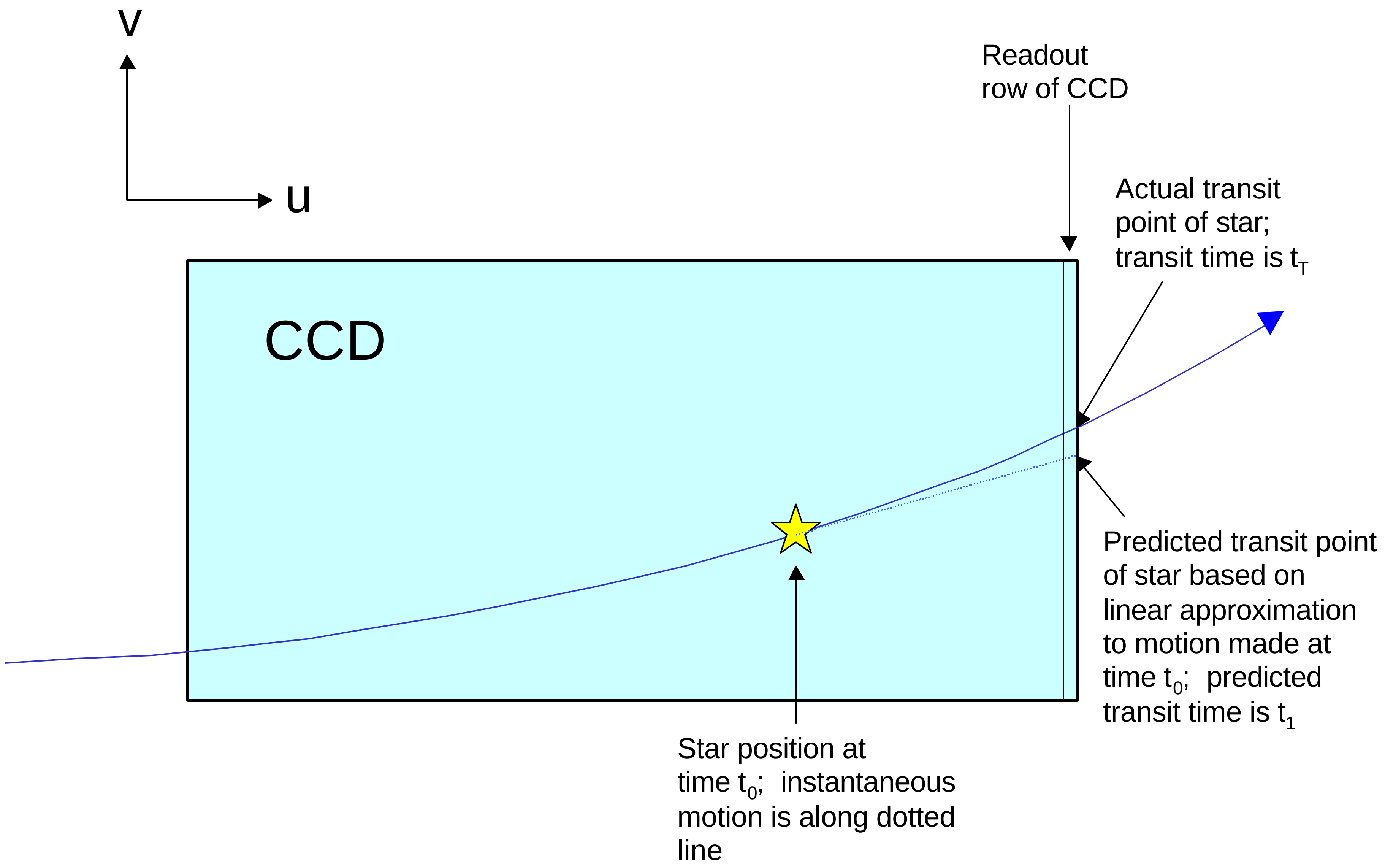
Notes

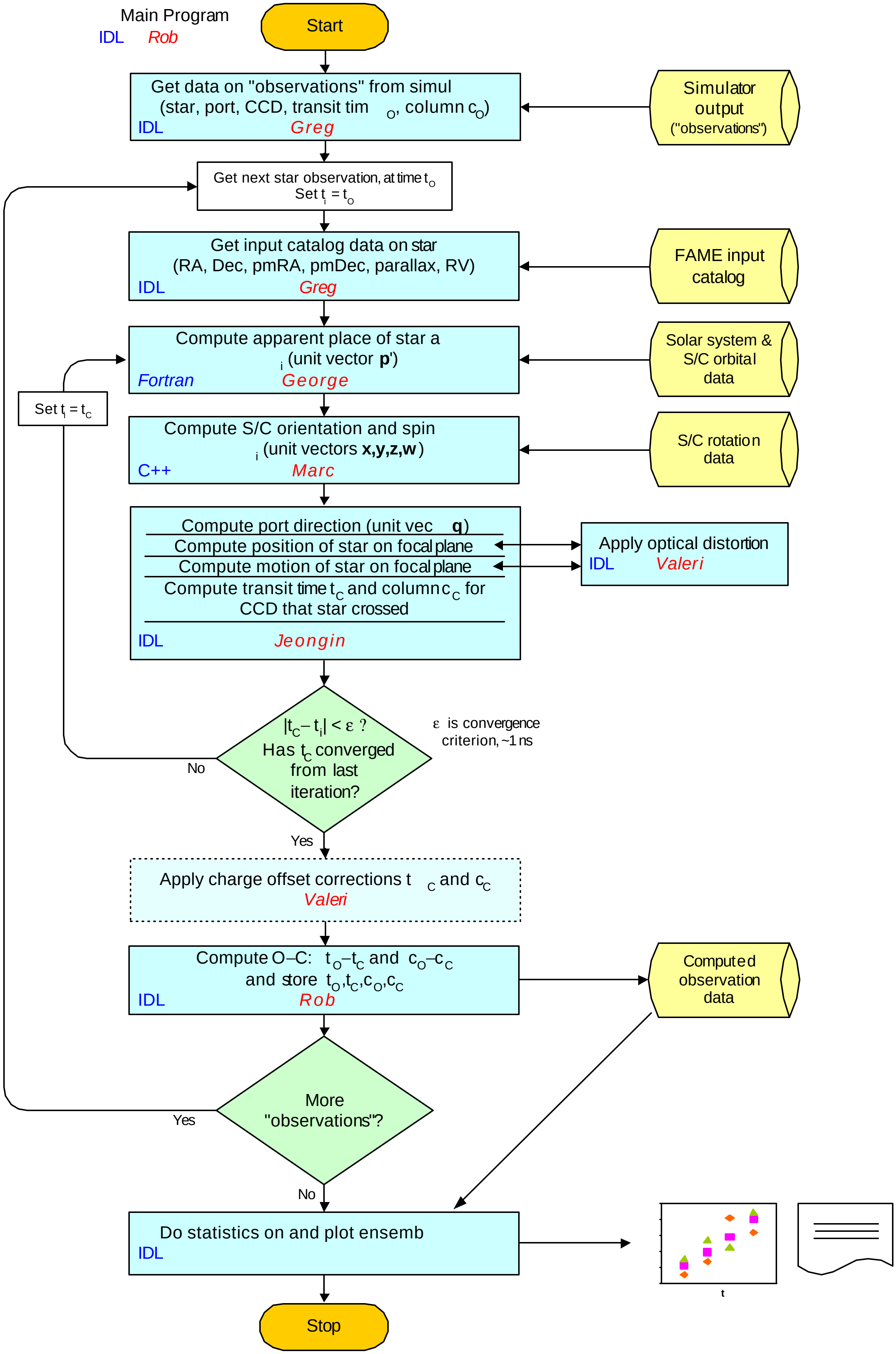
A "transit" consists of two parts: an in-scan precise timing (< 600 μas) and a less-precise (~5-15 mas) cross-scan position.

4.1. It will eventually be not only useful but essential that we introduce various kinds of errors into the input catalog. This allows us to quantify our (in)sensitivity to input catalog systematics.

Basis

- Separate treatment of photons and electrons:
  - First, compute time and column number that the photons of a star image will cross the last row of a CCD.
    - Straightforward geometry, including optical distortion
    - Based on linear approximation to star's path across CCD, applied iteratively if necessary
    - Use of real or simulated observation times as a starting point means that in most cases one iteration should be sufficient
  - Then, compute a correction for the offset of the electron distribution centroid, based on actual (curved) path of star across CCD. ← Under development
    - Scheme allows for sampling the position of the star on the CCD at as many time points as needed (hopefully only a few will be needed)
- Assumes that computation of the electron-photon difference does not require a numerically evaluated line integral over the star's path for each observations


v
u
Readout
row of CCD
Actual transit
point of star;
transit time is t_T
CCD
Predicted transit point
of star based on
linear approximation
to motion made at
time t_0; predicted
transit time is t_1
Star position at
time t_0; instantaneous
motion is along dotted
line


Main Program
IDL Rob
Start
Get data on "observations" from simul
(star, port, CCD, transit tim O, column cO)
IDL Greg
Simulator output ("observations")
Get next star observation, at time tO
Set ti = tO
Get input catalog data on star
(RA, Dec, pmRA, pmDec, parallax, RV)
IDL Greg
FAME input catalog
Compute apparent place of star a
i (unit vector p')
Fortran George
Solar system & S/C orbital data
Set ti = tC
Compute S/C orientation and spin
i (unit vectors x,y,z,w)
C++ Marc
S/C rotation data
Compute port direction (unit vec q)
Compute position of star on focal plane
Compute motion of star on focal plane
Compute transit time tC and column cC for CCD that star crossed
IDL Jeongin
Apply optical distortion
IDL Valeri
|tC − ti| < ε ?
Has tC converged from last iteration?
ε is convergence criterion, ~1 ns
No
Yes
Apply charge offset corrections t C and cC
Valeri
Compute O–C: tO–tC and cO–cC
and store tO,tC,cO,cC
IDL Rob
Computed observation data
More "observations"?
Yes
No
Do statistics on and plot ensemb
IDL
t
Stop

Time Variables

- Instrument Clock:

Integral seconds	Fraction of a second
4-byte integer	8-byte floating point

- TAI:

Not UTC!

Modified Julian date (including fraction)
8-byte floating point

precision ~1 ì sec

synchronization of TAI with instrument clock ~1 msec

NOVAS_FAME (Fortran)
Changes to Standard NOVAS

(1) Subroutines APSTAR, TPSTAR, APPLAN, TPPLAN, ASSTAR, ASPLAN, and MPSTAR removed, since they are specific to Earth-based observations.

(2) Subroutines VPSTAR, LPSTAR, VPPLAN, and LPPLAN have been modified as follows:

   (a) A TAI-based MJD is used as the input time argument. (The MJD is sent to GEO_PV directly (see 2d), but converted to a TT-based JD for calls to other NOVAS routines, where the highest time precision is not required.)

   (b) Input star catalog quantities assumed to be in Hipparcos-like units in the ICRS (J2000.0) coordinate system.

   (c) The epoch for the star catalog quantities is assumed to be JD 2453737.0 TT (2006.0).

   (d) The position and velocity of observer — i.e., FAME — is obtained from subroutine GEO_PV, which must be supplied.

   (e) The input arguments to LPSTAR and LPPLAN have been removed, since they are inappropriate for the FAME case.

   (f) The output argument from VPSTAR, LPSTAR, VPPLAN, and LPPLAN is a unit vector, not RA and Dec.

   (g) A return code was added as an output argument.

continued...

NOVAS_FAME changes, continued...

(3) Various changes made to subroutine VECTRS to be compatible with Hipparcos-like input units. Distance now computed from 1/sin(parallax). Zero-parallax case now set to 10^{-9} arcsec.

(4) Subroutine ANGLES modified to return RA in degrees.

(5) Subroutine SUNFLD expanded to compute deflection from all nine planets plus the Moon. (Not yet done.)

(6) Two previous versions of subroutine SOLSYS are included with names changed to SOLS2 and SOLS3. These subroutines are, respectively, SOLSYS version 2 (JPL ephemeris access) and SOLSYS version 3 (self-contained Earth). These are meant to be called from a version of SOLSYS, not supplied here, that can choose among various schemes for obtaining solar system data.

Possible future change:

Complete new relativistic paradigm, which would replace at least ABERAT and SUNFLD, and possibly VECTRS, PROPMO, and GEOCEN as well.

Status

- Portion of pipe to compute O-Cs from simulator data nearly complete
- Testing with simulator data to begin within a few days
- Estimated debugging time: 1 month

Next Steps

- Determine which parameters to initially solve for:
  - ù , ã, clock, CCD alignment errors, etc.
- Develop partials for those parameters; code and test
- Include WLS package into pipe
- Test parameter solutions with simulator data
- Develop and include electron centroid correction